Low-Cost, User-Friendly, Rapid Analysis of Dynamic Data System Established

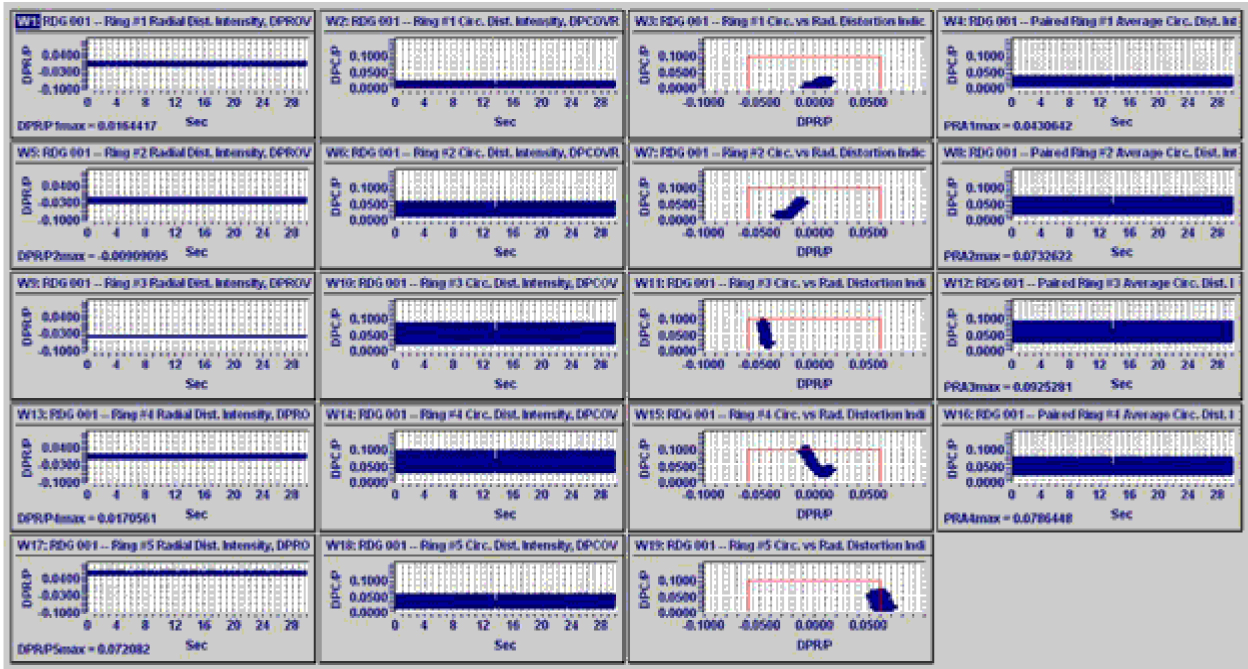
An issue of primary importance to the development of new jet and certain other air-breathing combined-cycle powered aircraft is the advancement of airframe-integrated propulsion technologies. Namely, engine inlets and their systems and subsystems are required to capture, convert, and deliver the atmospheric airflow demanded by such engines across their operating envelope in a form that can be used to provide efficient, stable thrust. This must be done while also minimizing aircraft drag and weight. Revolutionary inlet designs aided by new technologies are needed to enable new missions. An unwanted byproduct of pursuing these inlet technologies is increased time-variant airflow distortion. Such distortions reduce propulsion system stability, performance, operability, and life.

To countermand these limitations and fully evaluate the resulting configurations, best practices dictate that this distortion be experimentally measured at large scale and analyzed. The required measurements consist of those made by an array of high-response pressure transducers located in the flow field at the aerodynamic interface plane (AIP) between the inlet and engine. Although the acquisition of the necessary pitot-pressure time histories is relatively straight-forward, until recent years, the analysis has proved to be very time-consuming, tedious, and expensive.

To transform the analysis of these data into a tractable and timely proposition, researchers at the NASA Glenn Research Center created and established the Rapid Analysis of Dynamic Data (RADD) system. The system provides complete, near real-time analysis of time-varying inlet airflow distortion datasets with report quality output. This fully digital approach employs Institute of Electrical and Electronics Engineers (IEEE) binary data file format standardization to establish data-acquisition-system-independent processing on low-cost personal computers. Features include invalid instrumentation code-out, logging, and multiple replacement schemes as needed for each channel of instrumentation. The AIP pressure distribution can be interpolated to simulate measurements by alternate AIP probe arrays, if desired. In addition, the RADD system provides for the application of filters that can be used to focus the analysis on the frequency range of interest.

The most important capability of the RADD system is its ability to analyze dynamic inlet distortion in accordance with the Society of Automotive Engineers' (SAE) Aerospace Recommended Practice 1420 (ARP1420) guidelines (ref. 1). Off-the-shelf DADiSP (DSP Development Corporation, MA) digital signal analysis software is used to provide a full range of data management, processing, and presentation capabilities. In this way, users are provided with a very powerful suite of relevant capabilities that require only a minimum of programming effort. Fully validated, the RADD system has greatly enhanced and accelerated the processing of a wide array of dynamic inlet and other test data over previous capabilities. Opportunities for further development, such as the ability to generate color contour plots of selected scans of the AIP pressure distribution and in situ

production of Moving Picture Experts Group (MPEG) dynamic distortion movies, have been identified.



Typical screen-displayed summary output of a fully processed simulated dynamic inlet airflow distortion dataset provided by the RADD system.

Long description. This display consists of the time histories of the Society of Automotive Engineers' Aerospace Recommended Practice 1420 distortion index time histories plotted against their respective distortion limits. Because of the massive amounts of data that must be presented in a multiplot format for even a single data point, this figure is presented as a representation of what the RADD system provides and is not meant for analytical consideration

Reference

1. Gas Turbine Engine Inlet Flow Distortion Guidelines. Aerospace Recommended Practice 1420--Rev. B, Society of Automotive Engineers, 2002.

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